Seasomal variations of some blood parameters in cow

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SUMMARY
Thermal environment is a major factor that can negatively affect cow performance, especially in animals of high genetic value. Environmental conditions and in particular seasonal variations in air temperature and relative humidity are considered physiological stressors which affect the animal’s biological system. The effect of seasonal variation (winter, spring, summer and autumn) on some haematochemical parameters was evaluated on 43 multiparous Piemontese cows (5-12 years, mean body weight 530±78 kg), obtained from a farm located in Sicily, Italy (latitude 36° 53' 27"N, longitude 15° 4' 37"E, 152 m above sea level). For each season, ambient temperature and relative humidity were recorded by means of a data logger. The temperature-humidity index (THI) was also calculated as indicator of thermal comfort for animals. Blood samples were collected from each subject in January (T1 - winter season), April (T2 - spring season), July (T3 - summer season) and October (T4 - autumn season). Sera obtained were assessed by means of an automated analyzer UV Spectrophotometer (SEAC, Slim, Florence, Italy) on the following hematochemical parameters: total protein (TP), albumin, globulin, creatinine, urea, total bilirubin (TB), γ-glutamyltransferase (GGT), aspartate aminotransferase (AST), alanine aminotransferase (ALT). One-way repeated measures analysis of variance (ANOVA) was applied to determine significant effects of time on haematochemical parameters studied. P value <0.05 was considered statistically significant. The results obtained showed a statistical significant effect of time on: total protein (P<0.0001), albumin (P=0.01), globulin (P<0.0001), creatinine (P<0.0001), urea (P<0.0001), total bilirubin (P<0.0001), γ-glutamyltransferase (P<0.0001), aspartate aminotransferase (P<0.0001) and alanine aminotransferase (P<0.0001).

Our results showed variations in haematochemical parameters related to changes in ambient temperature, relative humidity and temperature-humidity index, although within the physiological range for cattle. Therefore, we can claim that the seasonal variations can influence the metabolic profile of Piemontese cow. These results provide insights into physiological responses of Piemontese cow to different seasons, allowing to better evaluate its ability to adapt and cope with environmental stress.

KEY WORDS
Cows, haematochemical parameters, seasonal variations, temperature-humidity index.

INTRODUCTION
Most animal species, including ruminant exhibit seasonal cycles of physiological functions. The production and reproduction performance of an animal depends not only on the flow of energy, food and water within the animal’s biological system, but also on its adaptability to the environment, in which it lives. The welfare of an individual is its state in regard to an attempt to cope with its environment. Welfare is closely linked to the concept of stress. Environmental conditions and in particular seasonal variations in air temperature and relative humidity are considered physiological stressors which affect the animal’s biological system. The variation in environmental variables such as ambient temperature, relative humidity, wind and rainfall were recognized as the potential hazards in livestock growth and production. In order to maintain homeothermy, an animal must be in thermal equilibrium with its environment, which includes radiation, air temperature, air movement and humidity. Thermal environment is a major factor that can negatively affect cow performance, especially in animals of high genetic value. Previous studies suggested that the temperature-humidity index (THI) could be used as indicator of thermal climatic conditions and stress on cows. Heat stress occurs when any combination of environmental conditions cause the effective temperature of the environment to be higher than the animal’s “thermoneutral” zone. Haematochemical parameters can be influenced by a number of factors such as age, physiological status and season. In particular, since environmental conditions are major stressors affecting animal’s biological system, we aimed to study the effect of seasonal variation (winter, spring, summer and autumn) on cows haematochemical parameters.
MATERIALS AND METHODS

Animals
A total of 43 multiparous Piemontese cows (5-12 years, mean body weight 530±78 kg), obtained from a farm located in Sicily, Italy (latitude 36° 53' 27"N, longitude 15° 4' 37"E, 152 m above sea level), were used for this study. All animals were clinically healthy and free from internal and external parasites, and resulted negative to the coprologic examination carried out using the flotation method before experimental period. Their health status was evaluated based on rectal temperature, heart rate, respiratory profile, appetite, fecal consistency, and hematologic profile. All animals were kept under natural photoperiod and environmental temperature. All cows were fed a constant diet composed of good-quality alfalfa hay and a concentrate mixture (oats 23%, corn 36%, barley 38%, and mineral and supplements 3%). The concentrate was formulated to meet the requirements of beef cows based on the recommendations of the National Research Council14. About 2.5 kg/animal of concentrate was distributed twice daily and water were available ad libitum.

Environmental conditions
Environmental conditions recorded during the experimental period are presented in Table 1. Thermal and hygrometric records were carried out for the whole study by means of a data logger with a high reading accuracy and resolution (Model Tinytag Ultra 2, Gemini Data Logger, West Sussex, United Kingdom) placed inside the stanchion barn. Temperature-humidity index (THI), used as indicator of thermal comfort for cattle, was calculated using the U.S. Weather Bureau’s Temperature Humidity Index Formula for bovine species (Potter and Jacobsen, 2000):

\[ THI = \frac{T_{\text{ambient}} + (0.36 \times \text{point of steam condensation})}{41.5} \]

Blood sampling and analysis
Blood samples, each of 10 ml, were withdrawn from jugular vein from each animal into vacuum tubes (BD Vacutainer Systems®) with no additive. Blood samples were taken from all cows in January (T1 - winter season), April (T2 - spring season), July (T3 - summer season) and October (T4 - autumn season) under differing environmental conditions. Samples were refrigerated and were later processed in the laboratory for analyses. The tubes were centrifuged at 3,500 rpm for 10 min and the obtained sera stored at -20°C until analysed. Sera were assessed by means of an automated analyzer UV Spectrophotometer (SEAC, Slim, Florence, Italy) on the following hematochemical parameters: total protein (TP), albumin, globulin, creatinine, urea, total bilirubin (TB), γ-glutamyltransferase (GGT), aspartate aminotransferase (AST), alanine aminotransferase (ALT).

Statistical analysis
One-way repeated measures analysis of variance (ANOVA) was applied to determine significant effects of time on haematoochemical parameters studied. P value <0.05 was considered statistically significant. Data were analyzed using statistical software Prism v. 4.00 (Graphpad Software Ldt., USA, 2003).

RESULTS

The ambient temperature, relative humidity and THI observed during the experimental periods (T1-T4) are shown in Figure 1. All results are expressed as means ± standard deviation (SD) in Table 2. One-way ANOVA showed a statistical significant effect of time on: TP (P<0.0001), albumin (P=0.01), globulin (P<0.0001), creatinine (P<0.0001), urea (P<0.0001), TB (P<0.0001), GGT (P<0.0001), AST (P<0.0001) and ALT (P<0.0001). The application of Bonferroni’s post-hoc comparison showed a statistical significant increase in TP values at T2 and T3 compared to T1. Albumin concentrations were decreased at T4 compared to T3. Globulin levels exhibited higher values at T2, T3 and T4 compared to T1. Creatinine values were higher at T2 and T3 compared to T1 and T4. Urea levels exhibited higher values at T3 compared to T1, T2 and T3, and at T2 compared to T4. TB values were lower at T1, T2 and T3 compared to T4, and at T3 compared to T2. GGT levels exhibited higher values at T2 and T3 compared to T1, and at T2 compared to T4. AST values were lower at T1 and T3 compared to T2 and T4. ALT values were higher at T2 compared to T1 and T3, and at T4 compared to T3 (Figure 1).

DISCUSSION

Environmental stress exerts pronounced effects on the various biochemical characteristics of blood. Agreed with previous studies15,16, our results showed an increase in total protein and globulin associated with the rise in ambient temperature. The increase in serum protein could be a physiological attempt to maintain extended plasma volume3. Variations in serum protein concentration were observed in lactating cattle and buffaloes during spring and summer seasons17,18. The increase of albumin levels during the summer period can be due to the increase in the osmotic pressure exerted by albumin2. High albumin levels are almost always caused by dehydration. The dehydration leads to haemoconcentration through reduction in fluid volume and consequent hyperproteinemia19. The increased values of globulin and creatinine under high environmental temperatures suggest that this adaptation is related to a metabolic response of the lactating cow to the hot environment20. Exposure of cows to hot environment could stimulates thermoregulatory mechanisms and produces reduction in the rates of metabolism, feed intake and productivity20. Heat stress has been shown to increase catabolism of amino acids (AA) for energy21,22. Some of these AA could be derived from the protein mobilization of muscle tissue, which would support the summer increase in the plasma levels of...
creatinine observed in the current study. Increased protein catabolism could also explain the higher summer levels of creatinine through an increased renal activity. In the present study urea values were higher at highest temperatures, confirming results obtained in previous studies\textsuperscript{23,24} that could be attributed to an increased utilization of amino acids as energy source. This could results in a loss of extracellular fluid due to heat exposure, although protein content of diet could alter serum urea concentration\textsuperscript{25}. Determination of serum total bilirubin is valuable for the diagnosis of fatty liver in cows. Total bilirubin is often increased after calving\textsuperscript{23} and is also increased during periods of anorexia\textsuperscript{26}. Our results showed higher level of AST, ALT and GGT during the winter season. The increase in the activities of these enzymes in plasma is mainly due to the leakage of these enzymes from the liver cytosol into the blood stream, which reflects liver damage and disruption of normal liver function\textsuperscript{27}. Increased serum values of GGT usually reflect liver damage in dairy cattle\textsuperscript{28}. However, the significant parity effect observed for this parameter in healthy cows could be the result of major productive stress in multiparous cows\textsuperscript{16}. The increase in blood concentration of AST is considered one of the indicators of hepatic steatosis in postpartum period\textsuperscript{29,30}. Kaneko et al.\textsuperscript{19} estimated that the AST has a sensitivity of 94\% for steatosis and it reveals the presence of liver damage even in the absence of clinical manifestations\textsuperscript{31,32}. As stated by Saba et al.\textsuperscript{32}, higher levels of AST and ALT in cows are related to higher metabolic effort caused by lactation.

Heat tolerance today is considered one of the most important adaptive aspects in cattle\textsuperscript{33}, as genetic selection for milk and meat production has reduced heat tolerance\textsuperscript{4,34}. The ambient temperature and THI recorded at T4 were within the upper critical zone (Figure 2). The ideal ambient temperature ("thermoneutral" zone) for a cow is between 5°C and 25°C\textsuperscript{35}. As ambient temperature increases, it becomes more difficult for a cow to cool herself adequately and enters heat tolerance today is considered one of the most important adaptive aspects in cattle\textsuperscript{33}, as genetic selection for milk and meat production has reduced heat tolerance\textsuperscript{4,34}. The ambient temperature and THI recorded at T4 were within the upper critical zone (Figure 2). The ideal ambient temperature ("thermoneutral" zone) for a cow is between 5°C and 25°C\textsuperscript{35}. As ambient temperature increases, it becomes more difficult for a cow to cool herself adequately and enters heat tolerance today is considered one of the most important adaptive aspects in cattle\textsuperscript{33}, as genetic selection for milk and meat production has reduced heat tolerance\textsuperscript{4,34}. The ambient temperature and THI recorded at T4 were within the upper critical zone (Figure 2). The ideal ambient temperature ("thermoneutral" zone) for a cow is between 5°C and 25°C\textsuperscript{35}. As ambient temperature increases, it becomes more difficult for a cow to cool herself adequately and enters heat
stress. THI values of 70 or less are considered uncomfortable, 75-78 stressful, and values greater than 78 cause extreme distress with lactating cows being unable to maintain thermoregulatory mechanisms or normal body temperatures.

CONCLUSION

Our results showed variations in haematological parameters related to changes in ambient temperature, relative humidity and temperature-humidity index, although within the physiological range for cattle. Therefore, we can claim that the seasonal variations can influence the metabolic profile of Piemontese cow. These results provide insights into physiological responses of Piemontese cow to different seasons, allowing to better evaluate its ability to adapt and cope with environmental stress.

References